Thermodynamic Simulation Of Hydrogen Chemisorption In Hydride Beds Using External-Internal Cooling

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Abstract

In this study, the proficiency of an external and internally cooled hydride bed was tested. This was conducted using COMSOL Multiphysics® environment utilizing the Heat Transfer Module. This was combined with a custom chemisorption model based on Lototskyy's Metal hydride isotherm model. The custom model utilizes a sorption rate equation based on the activation energy of the chemisorption and the pressure-concentration gradient driving the chemisorption, where the lattice pressure is obtained using Lototskyy's model. Interfacing of the custom model was done by utilizing the ordinary differential equation module and interpolation of data obtained from Lototskyy's model. The simulative study found that a hydride bed utilizing external cooling combined with internal heat exchanger tubes; achieved significantly higher refuelling rates while reducing the effective tank volume. Conversely, it found that conventional externally cooled tanks, aided by finned heat sinks, sacrifice more effective volume with no advantage over the aforementioned in terms of refuelling rate. The external-internal heat exchanger hydride tank design considerably increases the refuelling rate of the tank while decreasing the effective hydrogen storage capacity resulting in its implementation being situational.